

WHAT IS CLAIMED IS:

1. A method of treating a patent foramen ovale, the method comprising:
advancing a catheter device having a proximal end, a distal end and at least one abrasive needle near the distal end through vasculature of a patient to position the distal end adjacent the patent foramen ovale;
exposing a plurality of abrasive needles from the catheter;
advancing the exposed abrasive needles through the patent foramen ovale; and
retracting the abrasive needles relative to the patent foramen ovale to abrade at least a portion of tissue adjacent the patent foramen ovale.
2. A method as in claim 1, wherein advancing the catheter comprises advancing through at least one of a femoral vein, an iliac vein, an inferior vena cava, a brachial vein, an axil vein, a subclavian vein, and a superior vena cava of the patient.
3. A method as in claim 1, wherein advancing the catheter comprises advancing over a guidewire.
4. A method as in claim 1, wherein exposing the abrasive needles comprises retracting a catheter body of the catheter to expose the needles out of at least one opening in the catheter body at or near the distal end of the catheter.
5. A method as in claim 1, wherein exposing the abrasive needles comprises advancing the needles relative to a catheter body of the catheter to expose the needles out of at least one opening in the catheter body at or near the distal end of the catheter.
6. A method as in claim 1, wherein advancing the abrasive needles comprises passing at least one of the needles through tissue adjacent the patent foramen ovale.
7. A method as in claim 1, wherein advancing abrasive needles comprises advancing the catheter.

8. A method as in claim 1, wherein retracting the abrasive needles comprises abrading at least a portion of the patent foramen ovale with serrated edges of the needles.

9. A method as in claim 1, further comprising:
advancing the abrasive needles through the patent foramen ovale again after the retracting step; and
retracting the needles to further abrade at least a portion of the tissue of the patent foramen ovale.

10. A method as in claim 9, further comprising repeatedly advancing and retracting the abrasive needles through the patent foramen ovale to achieve a desired amount of abrasion.

11. A method as in claim 1, further comprising using at least one visualization device to view the patent foramen ovale.

12. A method of treating a patent foramen ovale, the method comprising:
advancing a catheter device having a proximal end, a distal end and at least one abrasive needle near the distal end through vasculature of a patient to position the distal end adjacent the patent foramen ovale;
exposing the at least one abrasive needle from the catheter;
advancing the at least one exposed abrasive needle through heart wall tissue adjacent the patent foramen ovale; and
retracting the at least one abrasive needle relative to the tissue to abrade at least a portion of the tissue.

13. A method as in claim 12, wherein advancing the catheter comprises advancing through at least one of a femoral vein, an iliac vein, an inferior vena cava, a brachial vein, an axial vein, a subclavian vein, and a superior vena cava of the patient.

14. A method as in claim 12, wherein advancing the catheter comprises advancing over a guidewire.

15. A method as in claim 12, wherein exposing the at least one abrasive needle comprises retracting a catheter body of the catheter to expose the needle out of at least one opening in the catheter body at or near the distal end of the catheter.

16. A method as in claim 12, wherein exposing the at least one abrasive needle comprises advancing the needle relative to a catheter body of the catheter to expose the needle out of at least one opening in the catheter body at or near the distal end of the catheter.

17. A method as in claim 12, wherein exposing the at least one abrasive needle comprises exposing a plurality of needles.

18. A method as in claim 12, wherein advancing the at least one exposed abrasive needle comprises advancing the catheter.

19. A method as in claim 12, wherein retracting the at least one exposed abrasive needle comprises abrading at least a portion of the tissue with a serrated edge of the needle.

20. A method as in claim 12, further comprising:
advancing the at least one exposed needle through the tissue again after the retracting step; and
retracting the at least one exposed needle to further abrade at least a portion of the tissue.

21. A method as in claim 20, further comprising repeatedly advancing and retracting the at least one exposed needle through the tissue to achieve a desired amount of abrasion.

22. A method as in claim 12, further comprising using at least one visualization device to view the patent foramen ovale.

23. A method of treating a patent foramen ovale, the method comprising:
advancing a catheter device having a proximal end, a distal end and at least one abrasive needle near the distal end through vasculature of a patient to position the distal end adjacent the patent foramen ovale;

exposing a first abrasive needle from the catheter such that the exposed first abrasive needle extends through at least part of the patent foramen ovale;

exposing at least a second abrasive needle from the catheter such that the exposed second abrasive needle extends through the patent foramen ovale; and

retracting the first and second abrasive needles relative to the patent foramen ovale to abrade at least a portion of tissue adjacent the patent foramen ovale.

24. A method as in claim 23, further comprising:

exposing a third abrasive needle from the catheter such that the exposed third abrasive needle extends through the patent foramen ovale; and

retracting the third abrasive needle relative to the patent foramen ovale to abrade at least a portion of tissue adjacent the patent foramen ovale.

25. A method as in claim 24, further comprising:

exposing a fourth abrasive needle from the catheter such that the exposed fourth abrasive needle extends through the patent foramen ovale; and

retracting the fourth abrasive needle relative to the patent foramen ovale to abrade at least a portion of tissue adjacent the patent foramen ovale.

26. A method of treating a patent foramen ovale, the method comprising:

advancing a catheter device having a proximal end, a distal end and an energy transmission member near the distal end through vasculature of a patient to position the distal end adjacent the patent foramen ovale; and

transmitting energy from the energy transmission member to contact tissue adjacent the patent foramen ovale to induce closure of the patent foramen ovale.

27. A method as in claim 26, wherein transmitting energy comprises

transmitting at least one of laser energy, radio frequency energy, ultrasound energy and microwave energy.

28. A method as in claim 26, wherein transmitting energy comprises

transmitting cryogenic energy or removing energy via cooling.

29. A method as in claim 26, wherein transmitting energy causes the tissue

adjacent the patent foramen ovale to weld together to close the patent foramen ovale.

30. A method as in claim 26, further comprising inserting at least one needle into the tissue adjacent the patent foramen ovale to enhance transmission of the energy to the tissue.

31. A method as in claim 30, wherein inserting the at least one needle draws the tissue together to enhance the transmission of energy to the tissue.

32. A method of treating a patent foramen ovale, the method comprising:
advancing a catheter device having a proximal end, a distal end and at least one aperture near the distal end through vasculature of a patient to position the distal end adjacent the patent foramen ovale; and
dispensing at least one fluid from the at least one aperture to contact tissue adjacent the patent foramen ovale to induce closure of the patent foramen ovale.

33. A method as in claim 32, wherein dispensing the fluid comprises dispensing a biocompatible fluid selected from the group consisting of an acid and an adhesive.

34. A method as in claim 32, further comprising inflating an expandable balloon coupled with the catheter device near the distal end to inhibit blood flow through the patent foramen ovale to enhance contact of the at least one fluid with the tissue adjacent the patent foramen ovale.

35. A method of treating a patent foramen ovale in a heart, the method comprising:
advancing a catheter device having a proximal end and a distal end through vasculature of a patient to position the distal end adjacent the patent foramen ovale; and
delivering a closure device at least partially through the patent foramen ovale to induce closure of the patent foramen ovale,
wherein a portion of the closure device disposed within the patent foramen ovale applies lateral force against tissues at opposite sides of the patent foramen ovale to bring tissue between the sides together.

36. A method as in claim 35, further comprising transmitting energy comprising at least one of laser energy, radio frequency energy, ultrasound energy and

microwave energy from the catheter to secure the closure device to the tissues adjacent the patent foramen ovale.

37. A method as in claim 36, further comprising delivering a tissue solder material which is set by the energy to adhere the closure device to the tissue.

38. A method as in claim 35, further comprising transmitting cryogenic energy or removing energy via cooling from the catheter to secure the closure device to the tissues adjacent the patent foramen ovale.

39. A method as in claim 36, 37 or 38, wherein transmitting energy causes the tissue adjacent the patent foramen ovale to weld together to close the patent foramen ovale.

40. A method as in claim 35, further comprising allowing the closure device to collapse and draw the patent foramen closed.

41. A method as in claim 35, further comprising positioning a backstop apparatus in the left atrium as the closure device is deployed.

42. A method as in claims 35, further comprising inflating an expandable balloon coupled with the catheter device near the distal end to deploy the closure device within the patent foramen ovale.

43. A method as in claim 35, wherein delivering the closure device comprises:

releasing a left atrial portion of the closure device from the catheter device such that it contacts tissue adjacent the patent foramen ovale from within in a left atrium of the heart; and

releasing a right atrial portion of the closure device from the catheter device such that it contacts tissue adjacent the patent foramen ovale from within in a left atrium of the heart,

wherein a bridging portion of the closure device extends through the patent foramen ovale between the left atrial portion and the right atrial portion and applies the lateral force.

44. A method as in claim 43, wherein the left atrial portion is released before the right atrial portion.

45. A method as in claim 43, wherein the right atrial portion is released before the left atrial portion.

46. A method as in claim 43, further comprising:
removing the closure device from the patent foramen ovale through using the catheter device; and
repositioning the closure device at least partially through the patent foramen ovale and in contact with tissue adjacent the patent foramen ovale.

47. A method as in claim 46, wherein removing the closure device comprises:
advancing the catheter device over the closure device to straighten the closure device; and
retracting the catheter device to remove the closure device from the patent foramen ovale.

48. A method as in claim 47, wherein the left atrial portion is straightened before the right atrial portion.

49. A method as in claim 47, wherein the right atrial portion is straightened before the left atrial portion.

50. A method of treating a patent foramen ovale in a heart, the method comprising:
disposing at least a portion of a closure device within the patent foramen ovale; and
applying lateral, oppositely directed force to tissues at opposite sides of the patent foramen ovale, using the portion of the closure device disposed in the patent foramen ovale, so as to bring a septum primum and a septum secundum between the opposite sides into contact.

51. A method as in claim 50 further comprising placing at least one device to maintain the contact between the septum primum and septum secundum.

52. A method as in claim 51 wherein placing the at least one device comprises placing at least one spring clip.

53. A method as in claim 51 wherein placing the at least one device comprises placing at least one staple.

54. A method as in claim 51 further comprising applying energy to maintain the contact between the septum primum and septum secundum.

55. A method as in claim 54 further comprising introducing tissue solder to maintain the contact between septum primum and septum secundum.

56. A method of treating a patent foramen ovale in a heart, the method comprising:

advancing a catheter device having a proximal end and a distal end through vasculature of a patient to position the distal end adjacent the patent foramen ovale; and

delivering a self-closing closure device from the catheter to contact tissues adjacent the patent foramen ovale,

wherein the delivered self-closing closure device closes to bring together the tissues the patent foramen ovale.

57. A method as in claim 56, wherein delivering the self-closing closure device comprises driving multiple tissue attachment members coupled with a self-closing stent into the tissues.

58. A method as in claim 56, further comprising transmitting energy comprising at least one of laser energy, radio frequency energy, ultrasound energy and microwave energy from the catheter to secure the closure device to the tissues adjacent the patent foramen ovale.

59. A method as in claim 56, further comprising transmitting cryogenic energy or removing energy via cooling from the catheter to secure the closure device to the tissues adjacent the patent foramen ovale.

60. A method of treating a patent foramen ovale in a heart, the method comprising:

attaching a closure device to a limbus of a fossa ovalis of the heart; and
allowing a portion of the closure device to hang from the limbus to cover an
opening of the patent foramen ovale.

61. A method as in claim 60 further comprising applying energy to secure
the closure device to at least one of the limbus and other tissues adjacent the patent.

62. A method of treating a patent foramen ovale in a heart, the method
comprising:

advancing an elongate catheter device through septum primum tissue near the
patent foramen ovale;

adjusting a retractable delivery arm from the catheter device, the delivery arm
coupled with a distal end of the catheter device via a universal joint; and

manipulating the catheter device to deploy a spiral needle from the delivery
arm into tissues adjacent the patent foramen ovale to bring the tissues together.

63. A method as in claim 62, wherein the spiral needle is deployed through
septum primum and septum secundum tissues.

64. A method as in claim 62, wherein manipulating the catheter device
comprises turning or twisting the device about its longitudinal axis.

65. Apparatus for treating a patent foramen ovale, the apparatus
comprising:

an elongate catheter body having a proximal end and a distal end; and

at least one retractable abrasive needle movable between a retracted position
wherein the needle resides wholly within the catheter body and a deployed position wherein
at least a portion of the needle extends through an opening in the catheter body adjacent the
distal end.

66. Apparatus as in claim 65, wherein the catheter body is passable over a
guidewire.

67. Apparatus as in claim 65, wherein the at least one retractable abrasive
needle comprises at least one serrated edge for abrading tissue adjacent the patent foramen
ovale.

68. Apparatus as in claim 67, wherein the at least one retractable abrasive needle comprises multiple needles.

69. Apparatus as in claim 68, wherein each of the multiple needles is individually retractable into the catheter body.

70. Apparatus as in claim 65, wherein the at least one retractable abrasive needle is movable relative to the catheter body to extend the at least one needle through the patent foramen ovale and retract the needle back through the foramen ovale.

71. Apparatus as in claim 65, further comprising at least one visualization device coupled with the catheter body near the distal end for visualizing at least one of the patent foramen ovale and tissue surrounding the patent foramen ovale.

72. Apparatus for treating a patent foramen ovale, the apparatus comprising:
an elongate catheter body having a proximal end and a distal end; and
at least one energy transmission member coupled with the catheter body adjacent the distal end for transmitting energy to contact tissue adjacent the patent foramen ovale to induce closure of the patent foramen ovale.

73. Apparatus as in claim 72, wherein the energy transmission member transmits at least one of laser energy, radio frequency energy, ultrasound energy and microwave energy.

74. Apparatus as in claim 72, wherein the energy transmission member comprises at least one of a cryogenic energy transmission member and a cooling member.

75. Apparatus as in claim 72, further comprising at least one retractable needle coupled with the catheter body for inserting into the tissue to enhance transmission of energy to the tissue.

76. Apparatus as in claim 75, wherein the at least one retractable needle comprises at least one surface having serrations.

77. Apparatus as in claim 75, wherein the at least one retractable needle draws the tissue together to enhance transmission of energy to the tissue.

78. Apparatus for treating a patent foramen ovale, the apparatus comprising:
an elongate catheter body having a proximal end and a distal end; and
at least one aperture in the catheter body adjacent the distal end for dispensing at least one fluid to contact tissue adjacent the patent foramen ovale to induce closure of the patent foramen ovale.

79. Apparatus as in claim 78, wherein the fluid comprises a biocompatible fluid selected from the group consisting of an acid and an adhesive.

80. Apparatus as in claim 78, further comprising an expandable balloon coupled with the elongate catheter body near the distal end for inhibiting blood flow through the patent foramen ovale to enhance contact of the at least one fluid with the tissue.

81. Apparatus for treating a patent foramen ovale, the apparatus comprising:
an elongate catheter body having a proximal end and a distal end; and
at least one closure device deployable from the catheter body, wherein the closure device attaches to tissue adjacent the patent foramen ovale and self-closes to bring the tissues together.

82. Apparatus as in claim 81, wherein the at least one closure device is biodegradable.

83. Apparatus as in claim 81, wherein the at least one closure device comprises an expandable, self-closing stent coupled with a plurality of tissue attachment members.

84. Apparatus as in claim 83, wherein the tissue attachment members comprise tissue piercing needles.

85. Apparatus as in claim 81, wherein the at least one closure device includes a portion extending within the patent foramen ovale to apply lateral force to tissue at

opposite sides of the patent foramen ovale, thus bringing together tissue between the opposite sides.

86. Apparatus as in claim 81, wherein the catheter body is passable over a guidewire.

87. Apparatus as in claim 81, further comprising at least one visualization device coupled with the catheter body near the distal end for visualizing at least one of the patent foramen ovale and tissue surrounding the patent foramen ovale.

88. Apparatus as in claim 81, further comprising at least one energy transmission member coupled with the catheter body adjacent the distal end for transmitting energy to contact tissue adjacent the patent foramen ovale.

89. Apparatus as in claim 88, wherein the energy transmission member transmits at least one of laser energy, radio frequency energy, ultrasound energy and microwave energy.

90. Apparatus as in claim 88, wherein the energy transmission member comprises at least one of a cryogenic energy transmission member and a cooling member.

91. Apparatus for treating a patent foramen ovale comprising a clip expandable from a first dimension to a second larger dimension sized to engage the tissue of the patent foramen ovale, wherein the clip in the larger dimension applies lateral force to tissue at opposite sides of the patent foramen ovale to bring tissues between the opposite sides together, and wherein the clip can revert or be made to revert to its first dimension.

92. Apparatus for treating a patent foramen ovale comprising:
an elongate catheter body having a proximal end and a distal end; and
at least one force application member coupled with the distal end for applying lateral force to opposite sides of the patent foramen ovale, thus bringing tissues between the opposite sides into contact.

93. Apparatus as in claim 92 wherein the force application member comprises two opposing arms which deflect laterally to engage the opposite sides of the patent foramen ovale.

94. Apparatus as in claim 92 wherein the force application member comprises a detachable closure device.
95. Apparatus as in claim 92 further comprising energy delivery means.
96. Apparatus as in claim 95 further comprising means to deliver tissue solder or adhesive.
97. Apparatus as in claim 92 further comprising means to deliver a closure device.
98. Apparatus as in claim 97 wherein the closure device comprises at least one staple.
99. Apparatus as in claim 97 wherein the closure device comprises at least one clip.
100. Apparatus as in claim 97 wherein the closure device comprises tissue solder or adhesive.
101. Apparatus for treating a patent foramen ovale comprising:
an attachment member for attaching to a limbus of a fossa ovalis of the patent foramen ovale; and
a covering member coupled with the attachment member for extending from the limbus to cover an opening of the patent foramen ovale.
102. Apparatus as in claim 101 wherein the covering member comprises:
a support structure; and
a mesh covering the support structure.
103. Apparatus as in claim 102 wherein the support structure comprises a wire frame.
104. Apparatus as in claim 101 further comprising energy delivery means for delivering energy to secure the covering member to tissue adjacent the patent foramen ovale.

105. Apparatus as in claim 104 further comprising means for introducing tissue solder or adhesive.

106. Apparatus as in claim 101 wherein the attachment member is configured to penetrate the tissue of the limbus.

107. Apparatus as in claim 106 wherein the attachment member comprises opposable jaws.

108. Apparatus for treating a patent foramen ovale comprising:
an elongate catheter configured to pierce through septum primum tissue adjacent the patent foramen ovale;
a retractable delivery arm coupled with a distal end of the elongate catheter at a universal joint; and
a spiral needle coupled with and deployable from the retractable delivery arm, wherein turning the catheter deploys the spiral needle into tissue adjacent the patent foramen ovale.

109. Apparatus as in claim 108, wherein the spiral needle is configured to pierce through septum primum tissue and septum secundum tissue to bring the septum primum and septum secundum together.